Gamma Ray Bursts

Powerful gamma-ray emissions occur when a massive star collapses, forming a black hole, or when it explodes as Supernova.

Swift Observatory and Fermi Gamma-ray Space Telescope have jointly detected such an event, brightest ever, designated as GRB 221009A happening about two (2) billion ly from Earth. This particular burst was so intense, carrying enormous energy, that briefly dazzled scientific equipment. Luckily, China’s GECAM-C jumped into the picture allowing for measurements to complete.

Unsolved mistery is how photons travel for such an astronomical lenght. One theoretical explanation is that they are converted by magnetic fields into a hypothetical, dark matter partical called axion and reconstitute back after entering a magnetic field again. This theory is supported with findings from NASA space observatory Imaging X-ray Polarimetry Explorer (IXPE) and European Space Agency’s (ESA) Integral satellite. Apparently, magnetic sphere directs black hole radiation producing energy jets which create more power in a second than Sun during its entire, ten (10) billion years lifetime.

But what was the cause of this 18 TeV blast that outperformed Large Hadron

Collider (LHC) energies ranging from 6.8 to 13.6 TeV? Most probably, merger of two neutron stars resulting in a magnetar birth - large, fast spinning neutron star enforced with strong magnetic field not further transforming into a black hole which happens within milliseconds of time.

In 2024., Large High Altitude Air Shower Observatory (LHAASO) in Daocheng County, China, recorded Gamma signal of Peta scale strenght (1-2.5), described as made in "bubble structure", originating in Cygnus constellation, which functions as cosmic particle accelerator driving energies up to 20 PeV before releasing them into a space.

Neutrinos and wimps

Neutrinos, enigmatic subatomic bits produced in extreme cosmic activities like star outbursts and neutron stars or black holes merge, are extremely hard to detect due to their infinitesimal weight and evasive skills.

IceCube Neutrino Observatory, built under the South Pole ice crust, and KM3Net (Cubic Kilometre Neutrino Telescope), constructed in Mediterranean Sea, serve the same purpose: detection of Cherenkov radiation, an electromagnetic emission, first observed around submerged nuclear reactor appearing as blue water glow. This mesmerizing spectacle triggers when

high energy ray moves through medium faster than its respective light speed limit influencing atoms along the path which in turn release photons.

Another type of specialized facility is searching for weakly interacting massive particle (wimp). This sensor fields use either magnetic spectrometer, supercooled crystals, liquified Xenon or Argon gas. Alpha Magnetic Spectrometer (AMS), installed on International Space Station (ISS), Cryogenic Dark Matter Search (CDMS), Silicon based, and Coherent Germanium Neutrino Technology (CoGeNT), Germanium based, both located inside Soudan Underground Mine in Minnesota, LUX-ZEPLIN experiment in USA, below the Black Hills in South Dakota, and DEAP-3600 array, inside a nickel mine in Ontario, are best examples of such endeavours.

Discovery of an elusive particles like neutrinos and wimps is aimed to help in quest of explaining dark matter properties and quantum gravity.

Gravitational waves

While measuring time intervals of radio waves emmited by pulsars, fast rotating neutron stars whose magnetic poles blast out energy, scientists at North American Nanohertz Observatory for Gravitational Waves (NANOGrav) detected wrinkles in spacetime fabric of such magnitude which can only

originate during supermassive black holes merger.

Experimental search for gravity began in 2015. when Laser Interferometer Gravitational-Wave Observatory (LIGO) sensors, already just after few months of starting the work, picked up subtle distortions.

Due to an individual inadequacy of Earth-based telescopes to properly detect spatial warping, largest telescopes in the world are combinedly used together with a galaxy wide sensor array in the form of pulsar fields.

Telescopes operate in an area known as Radio Quite Zone where wireless telecommunication signals are prohibited in order to prevent interference with sophisticated scientific equipment.

When gravitational waves contract or expand spacetime they also speed or slow time periods between pulsar made radio signals.

This inquiry confirms Eintein`s one hundred (100) years old prediction and is supposed to solve "final fraction of a second" question, link dark matter with primordial black holes and even explain nature of the gravity itself.

Precision has continued to be a limiting factor, due to the "quantum noise" - a smallest scale interference, but in recent years scientists have developed new technique called "squeezing". This approach significantly increases observational capacity at higher frequency level at a simultaneous cost of degrading it at lower ones.

Early black holes

Presence of a supermassive black holes, in an early stage of the Universe development, has been detected in galaxies CEERS 1019, where nine (9) million solar masses giant formed, just 570 million years after the Big Bang, UHZ1, where over ten (10) million solar masses behemoth formed, 470 million years after the Big Bang, and, most distant ever found, GN-Z11, where two (2) million solar masses heavy object formed, 430 million years after the Big Bang, surrounded with pristine Helium alone which explains smaller weight compared to forementioned two.

Discovery was made using deep space survey, with combined Webb infrared

and Chandra X-ray efforts, by searching for an unusually shining galactic cores called active nuclei (AGN). CEERS team, led by prof. Finkelstein - an astrophysicist from University of Texas at Austin, detected very fast moving gas which suggests strong gravitational pull originating in the middle of a clump.

These primordial black holes, predating galaxies formation, were created due to a collapse of an enormous particle clouds.

Universe faster expansion

By determining a rate of cosmic spread, called the Hubble constant, scientists estimate an age of the Universe to be 13.8 billion years and predict final possibilities such as never stopping expansion, collapse or rip.

There are two methods of calculating the Hubble constant: 1) Supernovae and pulsating stars (Cepheid variables) distance and movement monitoring, 2) cosmic microwave background radiation analysis. Results differ. First method yielded 73.3 km/sec/Mparsec (Hubble/Gaia) while second (Planck) gave 67.4 km/sec/Mparsec rate of expansion. This discrepancy is called Hubble tension. To resolve it new method has been developed which includes detection of a gravitational waves from colliding neutron stars. Result is right

in between known two constant values: 70 km/sec/Mparsec.

New observations made using Webb space telescope indicate that Universe is receding slightly faster than it was previously thought: 74.03 km/sec/Mparsec. Moreover, expansion is accelerating with distance.

Implications of these findings are shocking especially if we look beyond boundaries of the known Universe: constants value would require adjustment, current scientific views will have to modify accordingly and fine tuning argument for intelligent design shall be made obsolete.

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